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Modeling Fluid Flow in Porous Media

M.A. McGraw, B. Travis (LANL), H. Feng (Montclair State U.), and K.W. Jones (BNL)

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Matter can be transported by water flow through porous media either as a dissolved solute or sorbed to mobile colloidal particulates. Most groundwater flow models have neglected the second transport mechanism. The LANL model is being made more realistic by inclusion of a colloidal phase. The LANL colloid transport model is based on a probalistic algorithm, using pore size distribution, relative permeability, and capillary pressure curves. The model includes a coordination number, which is, roughly, the number of paths, or channels, that run into or out of each rock pore, on average. This type of model requires knowledge of the microstructure of the solid on a pore-size scale.

We used synchrotron x-ray computed microtomography (CMT) to obtain this information. Several samples of volcanic tuff from the Busted Butte study area were selected for analysis. The samples were a few mm in size, and the tomographic volumes were acquired with a voxel size of 0.0067 mm. We are analyzing the data using the medial axis software created by W.B. Lindquist of SUNY Stony Brook [1] to segment the tomographic data into pore space and rock space. The segmented data are then used to determine the distribution of pore sizes and connectivity of the sample. Calibration of the colloid transport model against column experiments requires a coordination number in the range of 5-7; we will compare this against the coordination numbers derived from the tomography experiments. A lattice Boltzman model simulation based on the tomographic data may also be used to generate relative permeability and capillary pressure curves for comparison with experimentally-derived curves.

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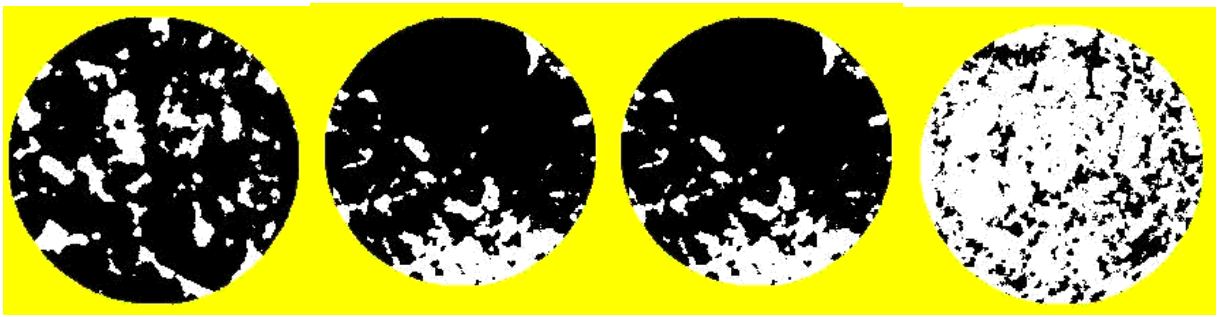
References:

[1]. W.B. Lindquist, S.-M. Lee, D.A. Coker, K.W. Jones, and P. Spanne, “Medial Axis Analysis of Void Structure in Three-Dimensional Tomographic Images of Porous Media,” *J. of Geophysical Research-Solid Earth*, **101B**, 8297-8310 (1996).



Four sections through a typical sample are shown The pore space is shown in white and the rock space is shown in black. The porosity of the sample changes radically over a distance of 1-2 mm. The high spatial resolution of the synchrotron CMT apparatus is essential for obtaining a precise determination of the variation of permeability and other parameters for input into the colloidal transport model that is under development at LANL.